Sensor Grand Challenges: An NVESD Perspective

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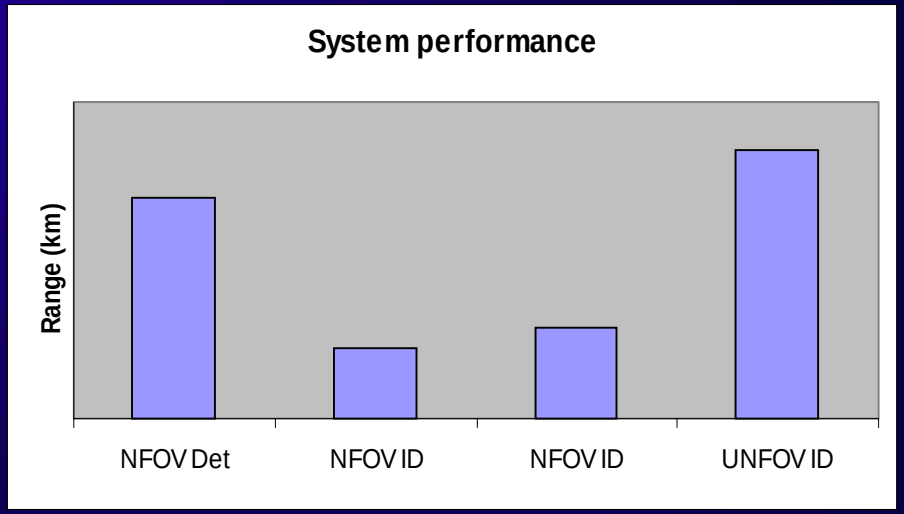
Sensor Grand Challenges

- 10 challenges for future sensor development to be presented.
- Challenges recently identified by Dr. Milton
- Some presently being addressed by specific program at NVESD, others more general
- Present status and future goals will be identified.

Challenge 1

See Before Being Seen

- Achieve an ID range that exceeds the enemy's detection range
- Avoids fratricide
- Possible Solution: UNFOV
- Program addressing this at NVESD: MFS3



Multifunction Staring Sensor Suite (MFS3) Exit Criteria

OPERATIONAL CAPABILITY	Baseline M2A3 FLIR	ATD Minimum	ATD Goal
Ground Target ID (Pid=0.90), ***Manual***			
Tank Target NFOV (1.5°)	1.0 X	1.75 X	1.9 X
Ultra-NFOV (0.5°)	N/A	2.8 X	3.5 X
Target Detection (Pd=0.70), ***Manual***			
Helo NFOV (1.5°)	TBM	4.2 X	5.1 X
UAV NFOV (1.5°)	TBM	9.5 X	12.0 X
Ground Target Det/Recg (Pd/r=0.50), ***Aided***			
Tank Target, NFOV (1.5°), ***MFS3 Stationary***	N/A	2.8 X	3.5 X
Tank Target, NFOV (1.5°), ***MFS3 On-The-Move*** (25 km/hr on Secondary Road)	N/A	2.2 X	2.8 X
Time to Detect (seconds)	90 *	10 Initial / 4 Update	10 Initial / 4 Update
False Alarm Rate	N/A	1.0 Y / FOR	1.0 Y / FOR
Field of Regard (FOR)	180° x 9° *	180° x 9°	360° x 9°

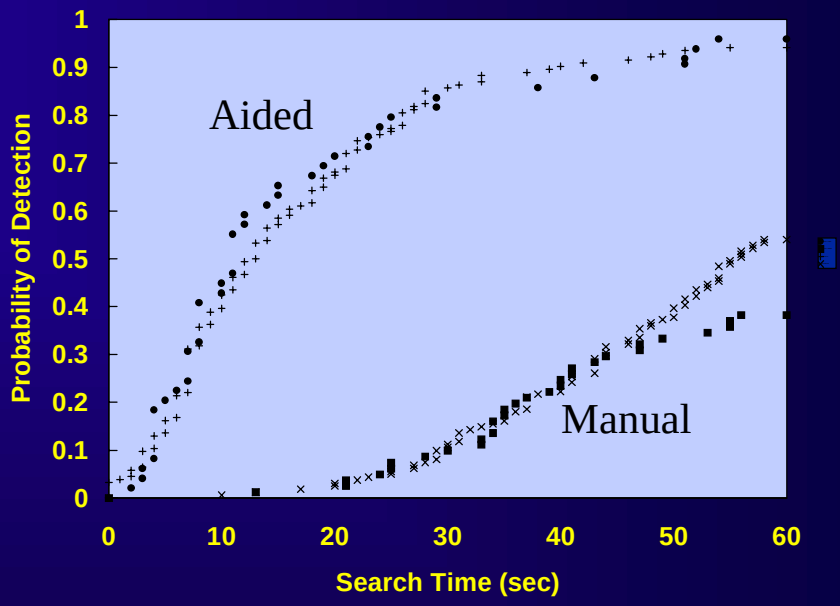
* Manual

Challenge 2

Decrease Target Acquisition Times

- Goal: reduce search time by 10x
- Possible solutions might involve:
  - Gimbal scan
  - AiTR/ATR
  - UNFOV
  - Multispectral staring
  - Passive MTI

Threat Acquisition Timeline**



**Source: Reago, et. al., Proceedings of 20th Army Science Conference, 1996

Challenge 3

Provide Superior Capability to Soldier at Reduced Cost/Weight/Power

- Present capability:
  - LTWS
  - 3.0 lbs
  - $10-12K (volume dependent)
  - 1.1W standby, 3.5W fully operational
- Goals:
  - $5K Sensor < 3 lbs
  - $1K Laser < 1 lb
  - $1K Display < 1 Watt

Provide Superior Capability to Soldier at Reduced Cost/Weight/Power

- Possible solutions might involve:
  - Innovative techniques for IR optics
  - Further improvements in detector fabrication techniques and performance
  - Fostering commercial applications

Challenge 4

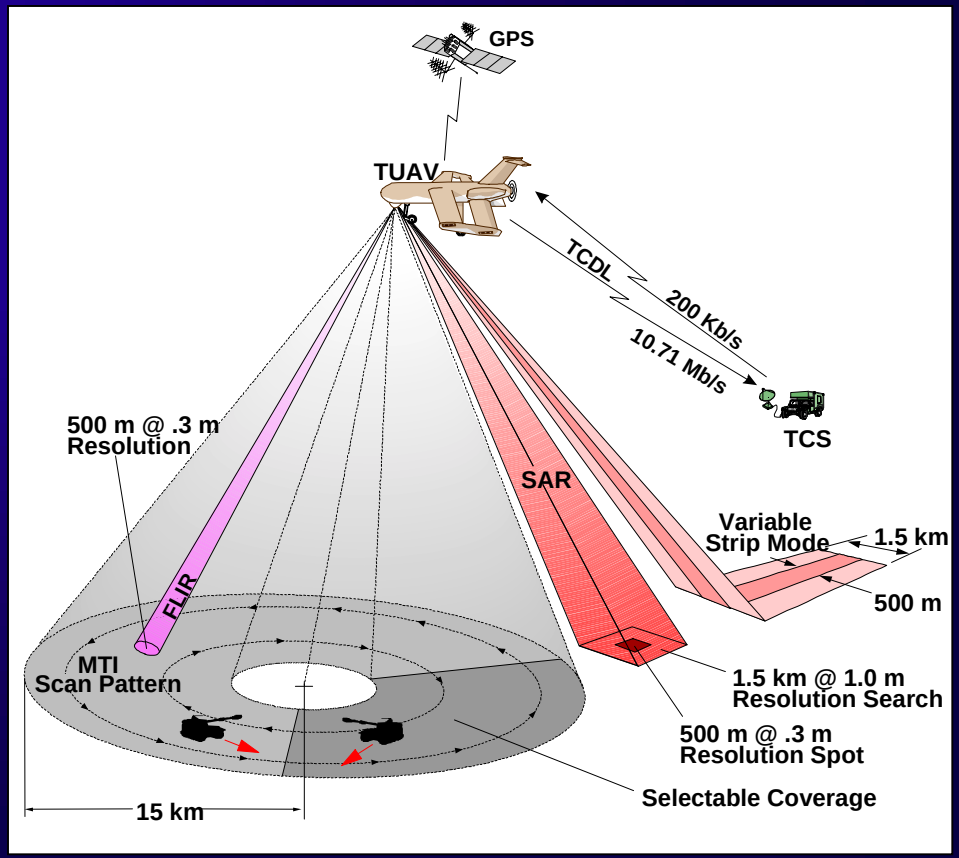
Detection of Partially Obscured and Low Observable Targets

- Goal: detection of hull-down tank at 5+km.
- Possible solution might include:
  - Multispectral discrimination capability

Challenge 5

Increase all-weather search rates within TUAV cost/weight constraints

- Present search rates 10 km²/hr
- Goal: EO/IR & SAR search at 150 km²/hr
- 60 lbs or less for sensor + processor
- $120-$150K for EO/IR sensor module



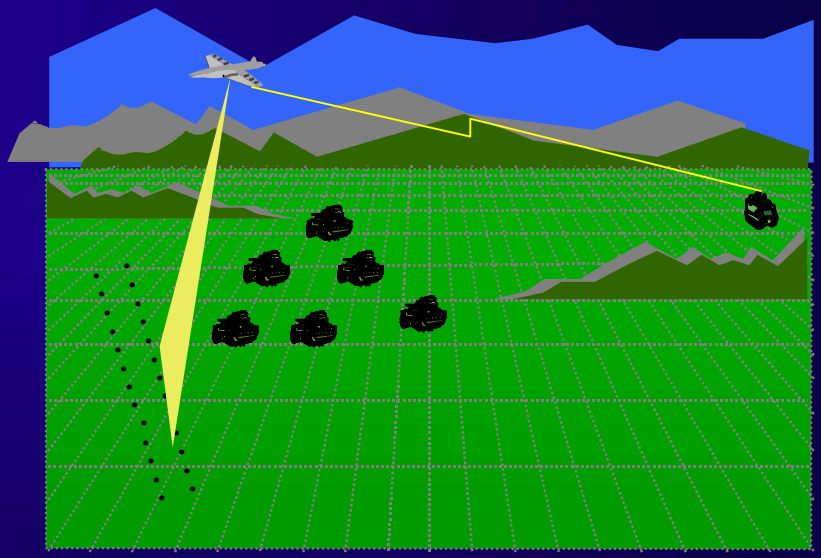
Tactical Countermining - Humanitarian Demining Contrasts

- Tactical Countermining
  - Focuses on enhancing force maneuverability and mobility.
  - Minefields must be rapidly detected in all possible conditions.
  - Breaching provides for rapid mine clearance through selected areas w/o the need for finding individual mines.
- Humanitarian Demining
  - Detection of **EACH** landmine is more important than the speed of movement.
  - Goal of demining is to locate and destroy **ALL** landmines within a large designated area.
  - **ECONOMIC CONSIDERATIONS** are important when deciding if and when a specific minefield will be cleared.
  - **SAFETY** is the most important consideration.
  - **CASUALTIES ARE UNACCEPTABLE.**

Challenge 6

Standoff Minefield Avoidance

- Goal: airborne minefield detection from > 1000 ft.
- No present fielded capability
- LAMD program addressing this need



Lightweight Airborne Multispectral Minefield Detection (LAMD) Exit Criteria

Operational Capability/Parameter	Exit Criteria	
	Minimum	Goal
• Probability of Detection		
- surface patterned minefields	80%	*95%
- buried patterned minefields	65 %	*80 %
- surface scatterable minefields	70 %	*85 %
- buried nuisance mines on unpaved roads	60 %	*75 %
• False Alarm Rate		
- false detections / square kilometer of area covered	FAR < 0.5	*FAR < 0.5
• Detection Accuracy		
- minefield edge	< 150 m	< 100m
- minefield boundary	n/a	< 150m
• Sensor Weight	< 65 lbs.	< 35 lbs.

* PD and FAR goals during defined operational conditions (i.e. time of day, environment, etc.). Conditions to be defined at the conclusion of the phenomenology investigations.

Challenge 7

Road Clearance at Reasonable Rates of Advance

- Present fielded capability: Hand held metal detector (AN/PSS-12) and nonmetallic mine probe
- High false alarm rate slows clearance.
- An approach to meeting this challenge = VMMD
  - Vehicle mount
  - Increased PD for all mines
  - Reduced FAR in all conditions
  - 3m swath for detectors

Vehicular Mounted Mine Detection (VMMD) Exit Criteria

Metric	ATD Exit Criteria	Minimum Field Requirement (Production)
Speed (Km/hr)	3.6	15
P_{det} (Surface)	95	95
P_{det} (buried)	92	95
False Alarm Rate (FA/m^2)	0.02	0.001
Mark Accuracy	< 1 meter	< 1 meter

VMMD Averaged Test Results

Mine Type	Detection Probability
Metallic Encased AT (Surface)	100
Metallic Encased AT (Buried)	>90
Non-metallic encased AT (Surface)	>90
Non-Metallic encased (Buried)	65-100

False Alarm rates = 0.05-0.25 /m^2

Challenge 8

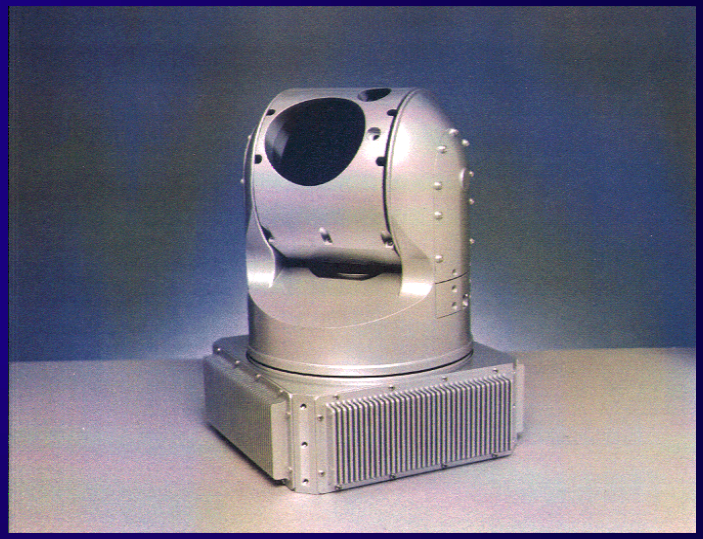
Affordable Humanitarian Demining

- Present methods usually involve metal detectors and manual probes.
- P_{det} for metal mines high but FAR high, slowing clearance.
- Presently investigating other detection methods.

Challenge 9

Protect Rotorcraft and Ground Vehicles From Advanced Seeker Missiles

- Goal: Vehicle self-protection for under $100K
- Present rotorcraft protection system (ATIRCM) uses multiple detection subsystems.
- No fielded ground vehicle self-protection suite.
- Possible solutions might include:
  - Multiple overlapping FOVs in single sensor head for warning system
  - Uncooled sensors

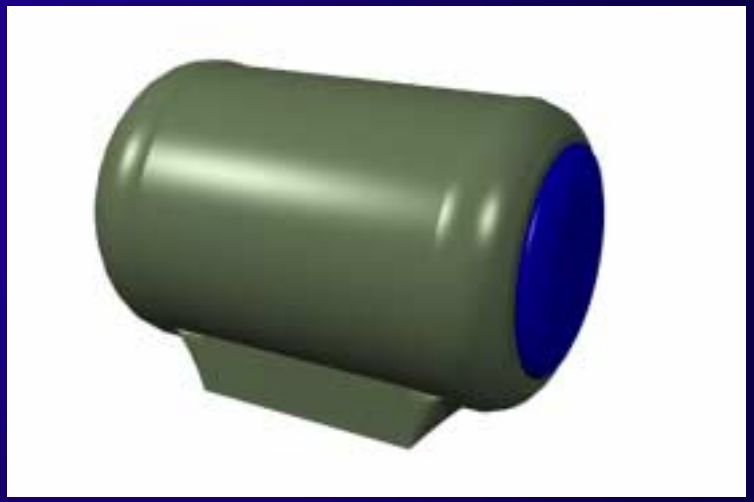


ATIRCM jam head

Challenge 10

Networked Situational Awareness

- Goal is for low cost distributed sensor networks
- Arrays of Micro IR Imaging sensors
- Other sensors in net: acoustic, seismic, RF, magnetic.



Warrior Extended Battlespace STO Objectives

Operational Capability	*Current Capability*	*STO Objectives*	
		Minimum	*Goal*
Size	**150 in^3**	**2 in^3**	**1 in^3**
Power	**10 W**	**1000 μ W**	**300 μ W**
Cost	**$20,000**	**$100**	**$50**
Deployment	**hand**	**air, hand**	**+munitions**
Training	**N/A**	**2 days**	**1 day**
Communications link	**5 km**	**100 km**	**200 km**
Unattended Operation	**30 days**	**60 days**	**120 days**

Summary

- Significant challenges facing sensor developers have been identified.
- Successfully meeting the challenges will provide substantial payoff in operational capability.
- Common themes:
  - Size/weight constraints
  - Automated/autonomous operation
  - Multispectral solutions
  - Cost often the major consideration